

Chapter 5: Monitoring

Monitoring, Evaluation and Adaptive Management

It is impractical and very inefficient to have individual and separate monitoring actions for each of the 502 GCN species. It is more practical to develop an effective monitoring framework or strategy that monitors the *status* and *condition* of species and habitats, conservation action effectiveness, and finally the incorporation of new information and adaptive responsiveness of this plan. This is one of the overarching conservation strategies identified in Chapter 4: “Develop programs and strategies to monitor key wildlife habitats and the effectiveness of conservation actions.”

The long-term successful implementation of Maryland’s WDCP will, as a minimum, prevent more GCN species from becoming increasingly rare and endangered, prevent key wildlife habitats from being degraded and irreparably lost, and minimize or eliminate threats to both. A critical measure of success will also include the reversal of population trends such that rare species will become more abundant and degraded key wildlife habitats will become restored and vital components of our natural landscape. These are long-term outcomes of the success of this WDCP, recognizing the many external factors that might limit implementation. Another important measure of the effectiveness and adaptability of this WDCP is the frequency and degree of use and integration of the WDCP targets into the programs and operations of DNR's many programs, as well as those of its partners and stakeholders. Therefore, Maryland’s monitoring framework and adaptive assessment strategy will focus on evaluating the long-term progress towards these broad objectives.

Table 5.1 summarizes a preliminary list of overall evaluation objectives and potential performance outcomes and measures to monitor the success of the WDCP and its numerous actions designed to conserve Maryland’s species and habitats in greatest need of conservation. It draws upon existing monitoring mechanisms and programs already in place (e.g., ACJV, multiple migratory bird plans, watershed plans), and it outlines how the objectives could be measured throughout implementation by MD DNR and its partners.

Table 5.1 Preliminary evaluation objectives and potential performance outcomes and measures to assess the success of the WDCP conservation measures.

Objective	Strategies / Actions	Measures of Outcomes
Key Wildlife Habitat Conservation	Conservation Actions, and Inventory, Monitoring & Research Projects	Acres/stream miles Key Wildlife Habitat conserved
		Acres/stream miles Key Wildlife Habitat restored or enhanced
GCN Species Conservation	Conservation Actions, and Inventory, Monitoring & Research Projects	GCN species occurrences with targeted stewardship implemented
		Species removed from State T&E list
		Species added to State T&E list

Objective	Strategies / Actions	Measures of Outcomes
		GCN species with lowered conservation status rank (e.g., S2 changed to S4)
		Species removed from GCN list
		Species added to GCN list
Biological Assessment	Threats assessment	Threats assessment updated
	Status, trends, limiting factor assessment	GCN species with status, trends and limiting factors assessed
	Population and habitat objectives	GCN population and key wildlife habitat objectives determined/updated
		State population and habitat objectives determined/updated
Research	Applied research projects	Research projects completed
		Research papers/reports published
		Adaptive mgmt applied based on findings
Conservation Design	Conservation planning projects	Core network of conservation lands identified
		Conservation plans written or revised
		Key wildlife habitats with GIS data updated
	Conservation tools	New GIS decision support tools developed
		Existing GIS decision support tools updated
		Predictive distribution models updated
		New predictive distribution models created
Monitoring and Evaluation	Monitoring programs	Existing monitoring programs utilized or modified to meet WDCP evaluation needs
		New monitoring programs developed
Information Management	Web-based data	Internet data pages developed
	Outcome tracking product	Outcome tracking data entered and available electronically
	Specific information products	Natural Heritage Database updated
		DNR databases/GIS layers updated
		New databases/GIS layers developed
		Data disseminated
Project Funding	Federal grants	Projects funded
		Dollars allocated
	State Wildlife Grants and other state grants	Projects funded
		Dollars allocated
	Other funding programs	Projects funded
Dollars allocated		
Partner Outreach	Outreach plan	Plan completed or updated
	Web site	Internet pages created or updated
	Partner meetings and presentations	Meetings with and presentations to NGOs, field units of federal agencies, ecosystem teams and others
Public Outreach &	Outreach Plan implemented	Objectives met through appropriate outreach techniques

Objective	Strategies / Actions	Measures of Outcomes
Education	Objective-based Educational products, meetings and events	Products produced (e.g., website, website frequent updates, periodic workshops and symposia and resulting publications. Other materials such as: maps and information packets)
Implementation effectiveness	Partners and stakeholders adopting WDCP targets (GCN species and key wildlife habitats) in their plans/programs	# partner/stakeholder plans using WDCP targets and implementing identified actions
		# plans revised within DNR and externally with GCN species, key wildlife habitats and actions used and accomplished
	Extent to which MD DNR can implement	% projects funded and completed

In addition to focusing on the measures for long-term progress toward the WDCP's overarching goals, the short-term outcomes of specific conservation actions for habitats, taxa groups, and species will be monitored, as appropriate. The outcomes of some of these activities will be much easier to track than others. Therefore, given the need to work within our limited time and funding, an early accomplishment will be to develop a prioritization scheme for tracking the detailed outcomes outlined in Chapter 4. Once a process for tracking the most important performance measures has been implemented, the remaining performance measures may be included, as funding allows.

Monitoring Framework: Monitoring GCN species and Key Wildlife Habitats

The first two objectives listed in Table 5.1 involve monitoring of GCN species and their key wildlife habitats. Chapter 4 identifies numerous priority monitoring needs for GCN species and key wildlife habitat status and condition. Maryland is fortunate to have an extensive monitoring system already in place, with hundreds of state, federal, local and grass-roots monitoring projects and programs. Appendices 1a and 5 list many of the existing plans and programs that have been developed by local, state, regional, national, or international partners that may include monitoring GCN species or their habitat components in Maryland. Many of the monitoring conservation actions identified in Chapter 4 were developed with these existing monitoring actions/plans in mind, as potentially providing the majority of the WDCP monitoring framework. Wherever possible this WDCP recommends and supports the full implementation of partners' plans (e.g., USFWS, ASMFC, PIF Bird Conservation Regions, TNC, PARC, BCI), especially those that have recommended or identified standardized monitoring actions and protocols for regional and/or national consistency. These existing monitoring efforts will be utilized as mechanisms to achieve WDCP conservation actions and implementation partnerships wherever applicable at the local, state, regional and national levels. Many of Maryland's monitoring efforts will be coordinated at these levels, through existing networks, such as USFWS Region 5 Migratory Bird Plans, PARC, and PIF, to ensure monitoring at the proper scale.

Within each key wildlife habitat, the most appropriate level of monitoring, whether it is at the species, guild, taxa, habitat or community level, will be identified to best monitor that "system" at the relevant ecological scale. Implementation of this WDCP also involves monitoring at a variety of geographic scales, including local, state, regional, national, and international, according to the suitability and recommendation of relevant partners' plans and programs. For example, the PARC recommends herpetofaunal monitoring with standardized protocols for the northeast and southeast regions, similar to USFWS and Partners In Flight BCRs and other regional, national and international bird conservation plans. As a result, Maryland's monitoring strategy will use the standardized regional protocols for reptile and amphibian monitoring in order to place Maryland's populations in the appropriate context. Other standardized monitoring protocols, such as those of the Breeding Bird Survey, International Shorebird Survey, North American Bat Conservation Partnership Strategic Plan, and American Fisheries Society, will be utilized wherever appropriate so that Maryland's data will be compatible with regional and national conservation efforts.

The DNR Monitoring and Non-Tidal Assessment Division (MANTA) has three interactive programs (Atmospheric Deposition, Ecological Assessments, and Monitoring) that assess the status and trends of biological communities in the state's non-tidal, freshwater rivers and streams (http://www.dnr.state.md.us/streams/pubs/pub_list.html). As a result, DNR already has a mechanism to monitor freshwater aquatic communities. The Maryland Biological Stream Survey (MBSS) conducts comprehensive biological and chemical monitoring of freshwater streams and rivers throughout the state and publishes reports on their health (e.g., Boward et al. 1999), allowing DNR to monitor GCN species that occur in those environments. The DNR Maryland Natural Heritage Program (NHP) tracks hundreds of species and natural communities, maintaining a detailed database on their abundance and distribution and providing DNR with an existing mechanism to monitor the status and trends of many GCN species and key wildlife habitats. Monitoring programs for certain species and taxa groups, such as puritan and northeastern beach tiger beetles, bog turtle, marshbirds, and colonial waterbirds, are ongoing, as are other monitoring programs within the Wildlife and Heritage Service (WHS), including mid-winter waterfowl surveys.

Implementation of the WDCP strategy will rely heavily on the existing monitoring projects and programs conducted by DNR partners. Dozens of community groups of volunteers participate in watershed-based water quality and stream monitoring, and the Maryland Water Monitoring Council serves as an umbrella organization for 14 of these groups. The MBSS program has created a guidance manual to educate volunteer stream monitors, creating a standardized system for data gathering (MD DNR 2000a). Appendix 5 shows the intensive and extensive level of ongoing monitoring efforts for water quality and stream and river habitats.

The USFWS, U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS), National Park Service (NPS), National Oceanic and Atmospheric Administration (NOAA) and Department of Defense (U.S. Army, U.S. Navy, U.S. Army Corps of Engineers) also monitor various fish and wildlife resources and their habitats in Maryland. The USFWS monitors migratory bird populations, federal endangered species, non-native invasive species such as nutria, wildlife on its several National Wildlife Refuges in

Maryland, and the Chesapeake Bay ecosystem in cooperation with its partners like EPA. The USGS has a research center at Patuxent with long-term monitoring programs for amphibians, birds, wildlife diseases, and water quality and quantity parameters. NPS monitors the habitats and wildlife resources of Assateague Island National Seashore, Chesapeake & Ohio Canal National Historical Park, and other NPS properties in the state. NOAA assesses the status and trends of many fisheries resources and the habitats at the Chesapeake Bay National Estuarine Research Reserve. The U.S. Army monitors fish, wildlife, and submerged aquatic vegetation habitats at its Aberdeen Proving Ground. The U.S. Army Corps of Engineers has comprehensive ecological monitoring programs for its island restoration projects in the Chesapeake Bay. The U.S. Navy monitors birds at Patuxent Naval Air Station, Bloodsworth Island, Indian Head, and other naval properties. Several of these federal partners also work with MD DNR and others to protect and monitor the resources of the Chesapeake Bay. By coordinating with these federal partners and others, DNR can better implement the WDCP's monitoring framework.

Chesapeake Bay may be one of the most monitored ecosystems in the country, with a wide range of state, federal, local, regional, academic and non-governmental research and monitoring programs. Recent water quality and habitat quality monitoring data for Chesapeake Bay, the Coastal Bays and estuarine tributaries (monthly and continuous data) are available online through the state's Eyes on the Bay Monitoring Program (<http://mddnr.chesapeakebay.net/eyesonthebay/index.cfm>). The Chesapeake Bay Monitoring Program, a part of the regional Chesapeake 2000 agreement, has several ecological components, which are detailed at <http://www.dnr.state.md.us/bay/monitoring/index.html>. The Chesapeake Bay Program maintains a clearinghouse of monitoring data on Chesapeake Bay's physical, chemical and living resources at <http://www.chesapeakebay.net/monprgms.htm>. Bay Program partners track more than 100 indicators of restoration progress and Bay watershed health; 89 of these use monitoring and tracking data, and the rest rely on computer modeling (CBP 2004a). The Alliance for Chesapeake Bay's Citizen Monitoring Program is a regional network of trained volunteers who track the condition of waters draining into Chesapeake Bay using weekly water quality tests throughout Maryland, Pennsylvania and Virginia (<http://www.alliancechesbay.org/project.cfm?vid=87>). By cooperating in such programs, DNR can maximize not only the monitoring data gathered but community involvement as well. Key wildlife habitats that can be monitored through this network of existing programs in Chesapeake Bay include Oligohaline Estuaries, Mesohaline Estuaries and Polyhaline Estuaries, and GCN species include shortnose sturgeon, Atlantic sturgeon, seaturtles, Northern diamond-backed terrapin, horseshoe crab, waterfowl, shorebirds, and many others.

In 2000, DNR was awarded a five-year grant from the EPA to create an integrated, comprehensive coastal monitoring program as part of the National Coastal Assessment initiative (also known as Coastal 2000). The objectives of the Maryland Coastal 2000 program are to assess the physical, chemical, and biological condition of the state's coastal waters using a standardized collection of environmental indicators and rank the relative importance of several stressors on these resources (http://www.dnr.state.md.us/coastalbays/water_quality/nca.html). The first year of monitoring (2000-2001) utilized 54 estuarine sites for water quality, benthic community,

sediment chemistry and sediment toxicity monitoring and 20 sites for fish sampling. In the second year (2002) the program was expanded to include 124 monitoring sites. Not only can the estuarine key habitats take advantage of this existing monitoring program, but the Tidal Marsh, Tidal Shrub Wetland, and Ocean key habitats can as well.

The Comprehensive Conservation and Management Plan (CCMP) for Maryland's Coastal Bays (MD DNR 1999) formulated a detailed monitoring strategy for the Coastal Bays that builds on 70 existing monitoring projects or programs in the estuaries and their watersheds. Part of the strategy is a comprehensive Eutrophication Monitoring Plan that incorporates landscape parameters (e.g. nutrient and chemical application rates, implementation of best management practices), stressors, and the responses of biological indicator species within the bays. The Maryland Coastal Bays Program, which is within DNR, is the lead implementation agency for the CCMP and its monitoring program. The existing monitoring programs for Maryland's coastal bays and Chesapeake Bay are integral to the WDCP's monitoring framework for key estuarine habitats and GCN species.

Although Maryland's aquatic habitats have extensive monitoring programs already in existence, such programs are not as numerous or robust for terrestrial habitats. DNR has ongoing GIS-based efforts related to forest fragmentation. The Strategic Forest Lands Assessment (SFLA) summarizes the distribution of the state's forested land base and the socioeconomic characteristics of the state's forest resources (MD DNR 1999b). This includes ownership, vulnerability to conversion, and spatial distribution of existing conservation efforts. DNR's Green Infrastructure Assessment (GIA) uses GIS technology to identify large, ecologically valuable forests and wetlands, as well as a network of connecting corridors, for targeted, coordinated conservation and restoration at the state and local levels (MD DNR 1999b). A GIS analysis of forest loss, especially within the Green Infrastructure, between 1997 and 2000 has already been completed (Weber and Aviram 2002). MD DNR has also developed a monitoring program for species and natural communities located within the recently acquired Chesapeake Forest on the lower Eastern Shore. Further use and development of various GIS tools, as well as on the ground programs, will be critical in the implementation, evaluation and adaptive management of this WDCP.

As stated in Chapter 4, a first iteration of the GIS layers that represent the distribution of Maryland's key wildlife habitats were developed as one of the steps in the process of creating the WDCP. These layers were developed using over ten different existing data sources, and the accuracy of these key wildlife habitat data layers varies greatly, ranging from field-verified locations to predictive models. Many will need additional ground-truthing and other quality control measures and refinements to increase their accuracy. However, they can serve as a starting point or baseline measure from which to begin assessing the overall level of "conservation ownership" status. Table 5.2 shows the acreages of each key wildlife habitat in Maryland and the breakdown of ownership, provided in percentages. Insufficient data were available for Forested Seepage Wetlands to develop an acceptable GIS layer for this key wildlife habitat.

Table 5.2 Acreages and Ownership Status of Maryland's Key Wildlife Habitats.

		OWNERSHIP OF TERRESTRIAL HABITATS (percent)					
KEY WILDLIFE HABITAT	Total Ac	Federal	State	Local	NGO	Easement	Private
Old Growth Forests	1,679	0.4	94.9				4.7
Early Successional Forests	116,531	1.4	20.0	1.6	0.2	1.1	75.6
Maritime Forests and Shrublands	1,612	92.5	6.3				1.2
Loblolly Pine - Oak Forests	394,545	1.8	12.2	0.6	1.3	1.1	82.9
Mesic Deciduous Forests	1,282,923	0.1	1.5	0.3		0.1	98.0
Dry Oak - Pine Forests	323,203	2.8	17.3	6.9	0.4	1.0	71.5
Northern Conifer - Hardwood Forests	70,059	1.6	26.8	1.6	0.6	0.5	68.9
Floodplain Forests	212,339	5.7	8.9	3.2	2.1	1.0	79.1
Upland Depressional Swamps	59,664	1.0	11.7	0.5	2.3	0.8	83.7
Carolina Bays	175		25.1		25.2		49.7
Vernal Pools	12,466	2.8	6.4	0.7	1.1	1.1	87.9
Forested Seepage Wetlands	unknown						
Bog and Fen Wetland Complexes	6,136	0.7	11.9	0.6	11.8	0.8	74.1
Nontidal Shrub Wetlands	14,842	3.6	11.2	4.4	2.5	1.8	76.4
Tidal Shrub Wetlands	7,034	5.4	9.8	3.0	1.7	3.5	76.6
Nontidal Emergent Wetlands	18,463	9.0	7.7	4.9	1.4	1.8	75.2
Tidal Marshes	211,098	12.6	28.4	0.6	1.3	2.6	54.5
Grasslands	241,671	4.8	3.3	1.3	0.3	1.5	88.9
Barrens and Dry Glades	6,921	3.1	33.8	23.4	2.1		37.6
Cliffs and Rock Outcrops	19,723	3.6	37.5	6.6	2.7		49.6
Caves, Mines, and Springs (number of locations)	1,114	2.3	3.3	0.6	0.7	0.6	92.5
Coastal Beaches, Dunes, and Mudflats	8,600	14.7	70.9	0.1		0.4	13.9

If monitoring programs do not currently exist for a GCN species or taxa group, either the monitoring actions for closely-related species occupying those same habitats may serve as surrogates or the need for new monitoring actions have been identified (Chapter 4). Within the next two years, important new monitoring needs will be reviewed and prioritized, and alternatives for implementing new monitoring conservation actions will be developed to benefit the overall key wildlife habitat, community, and/or assemblage, including many of the other GCN species, in order to maximize limited resources and maintain practicality and efficiency. In cases where not enough information exists to monitor a GCN species or key wildlife habitat, or monitoring protocols have not yet been developed, this need is documented and followed by a research action or other conservation action to address that

information need (Chapter 4). This is true for some taxa groups, such as small mammals and invertebrate groups, for which standardized protocols need to be developed and for taxa where baseline data do not exist to form the basis of a monitoring protocol. In these cases, these overarching taxa research or data needs are described in Chapter 3 under the appropriate taxa and may also be included, as appropriate, as specific Inventory, Monitoring and Research or Conservation Actions in Chapter 4 for associated key wildlife habitats.

In summary, the Conservation Actions and Inventory, Monitoring and Research sections discussed in Chapter 4 for each key wildlife habitat recommends numerous monitoring efforts, whether it be at the species, guild, taxa, or habitat or community level. The most current scientific information and expert opinion were used along with peer review, public and partner stakeholder workshop/web-site feedback, and coordination with partners to maximize effectiveness. Existing monitoring and survey systems (Appendix 5) will be utilized as the foundation from which to gain partner and stakeholder input and to identify appropriate, high priority new programs that could be developed, assuming the availability of sufficient funding.

Adaptive Assessment Strategy – Monitoring Effectiveness of Conservation Actions

Maryland's assessment strategy involves a long-term commitment to the success of the WDCP. Species populations that have been declining for decades may take decades to reverse and therefore decades before the results of conservation actions can be fully realized. Therefore, an effective assessment strategy incorporates the concept that many conservation actions involve different temporal scales; both short-term conservation actions (e.g., research projects), as well as the long-term strategies are necessary to effect adequate conservation of GCN species and key wildlife habitats. Furthermore, differing geographic scales need to be taken into account as well. For example, direct habitat conservation usually occurs at small geographic scales (e.g., a parcel of land is acquired); however, many GCN species still have large populations such that numerous individual conservation actions would need to occur before changes in overall population status would be detectable.

The assessment will initially rely on the results and reports from the numerous ongoing monitoring programs that are discussed above, such as the Maryland Biological Stream Survey, Chesapeake Bay Program, Coastal Bays Program, and ASMFC, and in Appendix 5. Within the next two years, select results from various research and conservation activities, as outlined in Chapter 4, will be managed in an "outcome tracking" database, which will be designed and developed for this purpose. This will increase the efficiency of synthesizing and analyzing the necessary information. It is important to note that the DNR Natural Heritage Program already monitors the status and trends of the rarest terrestrial and freshwater GCN species. This commitment alone already accounts for an assessment of 60% of all GCN species. Status and trend data for additional species can be tracked by adapting the existing Natural Heritage Program database or by developing additional data systems, as needed, to include data on the status of all GCN species, research and survey results, and ongoing inventory and monitoring projects.

As funding allows, additional web-based data entry and/or retrieval systems could be developed for DNR staff, researchers, and other partners, allowing data to be more easily shared and distributed. These electronic information management mechanisms may be linked with the USGS National Biological Information Infrastructure (NBII) network and with other regional and national partners' temporal and spatial monitoring efforts (e.g., NatureServe's Central Data Systems) to facilitate information sharing at the regional and national levels.

Ongoing adaptive management to guide the commitment of limited resources will be accomplished by periodic database review and analysis to track the implementation and success of WDCP objectives, strategies, and outcomes (for more on this process, see Chapter 6). Accomplishment measures may include assessing the acres/stream miles of habitat protected or improved through various means (i.e., acquisition by or donation to a conservation-oriented agency or organization, conservation easements, restoration or enhancement), research to fill data gaps, monitoring programs, information management, funding of conservation projects, and outreach to partners and the public. Specific conservation actions may be re-prioritized based on this periodic review of the implementation status. As funding permits, new data will be collected, compiled, and entered into the appropriate databases for regular monitoring and assessment of GCN species and key wildlife habitat resources.

Specific proposed criteria to evaluate the ongoing success of the WDCP conservation actions are measurable to be most effective in evaluating the performance of actions collectively. Criteria for the measurement of successful outcomes related to long-term goals may include the following subset of outcomes provided in Table 5.1:

1. A net increase in the acreage/stream miles of key wildlife habitat conserved through acquisition, easement, restoration, enhancement and/or creation.
2. The long-term reduction in the number of GCN species across the full array of wildlife.
3. A net increase in scientific knowledge of GCN species and key wildlife habitats.
4. Successful funding of the highest priority conservation projects.
5. Successful completion of the highest priority conservation projects.
6. An increase in partner and public involvement in achieving the conservation of wildlife diversity in Maryland.
7. The reduction or removal of threats to GCN species and key wildlife habitats through avoidance, minimization and mitigation measures.

The DNR NHP will coordinate a bi-annual review of the current status of the rarest GCN species. Database information and other input, including an evaluation of the most current scientific information and coordination with scientific experts, will guide decisions on potential changes needed in either conservation status ranks (i.e., S-ranks) or in the legal state protection status. Recommendations will be compiled for review and broader input by other agencies and the public.

In addition to these measurable criteria, the ability of the conservation actions to effectively address the needs of the fish and wildlife resources of Maryland will be monitored qualitatively. An improvement in the coordination of similar monitoring projects conducted by disparate sources would be one such qualitative measure. Coordination of all the avian monitoring projects, for example, through regional resources such as the Atlantic Coast Joint Venture Plan and BCRs, would enhance the efficiency of each project. This would lead to a qualitative improvement towards successfully implementing the WDCP goals and objectives for avifauna. Other qualitative measures for monitoring success may include the increased involvement of MD DNR in other statewide or regional conservation initiatives and the incorporation of DNR developed wildlife-focused habitat management guidelines into existing land use and planning efforts. By utilizing both quantitative and qualitative success criteria, the DNR will be responsive to the diverse nature, scope, and scale of the WDCP conservation actions. MD DNR will, with its partners, periodically review and reevaluate conservation actions and employ adaptive measures to keep the WDCP a dynamic process on track with the specific, current needs of Maryland's GCN species and their key wildlife habitats.